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Naturalistic Methods In Mosquito Abatement

By HAROLD FARNSWORTH GRAY, Engineer
Alameda County Mosquito Abatement District, Oakland

In recent years in California malaria has increased in certain areas, due in part to the influx of migrants from areas where malaria is endemic; equine encephalomyelitis also is either actually increasing, or is being more generally recognized and diagnosed. Malaria, of course, is definitely a disease transmitted solely by mosquitoes of the genus *Anopheles*. Various species of mosquitoes have been shown, by laboratory methods, to be capable of transmitting equine encephalomyelitis, and while the epidemiological evidence of such transmission is as yet incomplete and far from conclusive, it is sufficiently suggestive to make it advisable to include mosquito abatement in any control methods to be applied for the prevention of equine encephalomyelitis.

In the prevention of diseases known or suspected to be transmitted by mosquitoes, both the public in general and various official bodies turn naturally to their health officers for advice and counsel as to ways and means of prevention. You are, of course, relatively well informed as to the basic principles involved in the standard mosquito control methods, such as drainage and filling to eliminate mosquito breeding water, the use of oils, paris green and pyrethrum emulsions to kill mosquito larvae and pupae, and the uses and limitations of fish, such as *Gambusia affinis*, as a biological control method. There are, however, quite a number of other methods of mosquito abatement, some of them relatively old and some relatively new, with which few health officers in California have been acquainted, and concerning which you should be informed if your proper function as health advisors to your communities is to be adequately maintained. The type of control measures referred to are described under the group designation of "naturalistic" methods.

Frequently we receive advice that we ought to make more general use of biological methods of mosquito abatement. Such suggestions are usually presented by persons who have heard of the control of economic pests, such as the cottony cushion scale, by the introduction of parasites which practically eliminate the pests. However, mosquito breeding seems to be limited more by physical conditions such as available water, temperature and humidity, than by specific parasites which appreciably restrain the aquatic stages of mosquito development. It is true that there are numerous organisms which are predators on mosquito larvae, many kinds of fish, for example, being effective under certain conditions; but in general, under natural conditions, usually there is established a balance between predators and victims, and in the case of mosquitoes this balance is frequently at a level which permits a fairly large output of mosquitoes

with an appreciable nuisance or disease-transmitting capacity. Therefore, in general, the control of mosquitoes by true parasites appears to be impossible, and control by predators is successful only under particular conditions and within fairly well defined limits.

But careful studies of mosquito biology have shown that many species of mosquitoes are very susceptible to changes in their environment, and slight changes in the breeding water may make it impossible for a particular species to reproduce in significant numbers. Furthermore, in many instances it is possible to bring about slight but effectively unfavorable changes in environment by fairly simple methods which involve relatively small costs. Such simple environmental changes are termed "naturalistic" abatement methods, to distinguish them from purely biological methods such as the introduction of parasites or predators. The most general usage of the term "naturalistic" abatement would include also the more narrowly limited idea of biological control.

Naturalistic abatement measures are not new, though their application has materially increased in the last few years. Stream bed flushing, for example, was used by Sir Ronald Ross at Ismalia, in 1903, and by J. A. LePrince at Panama in 1905. Dr. Henry Rose Carter of the U. S. Public Health Service as far back as 1914 saw the significance of the changes in water level in southern mill ponds due to the week-end shut down, in diminishing the breeding of *Anopheles quadrimaculatus,* and this observation has been the basis of one of the principal control methods used today against this mosquito in impounding reservoirs in the southeastern states. Naturalistic abatement measures have been used extensively in Malaya, Ceylon and India, for example, and L. W. Hackett and his associates have developed their application in Europe; and in California W. B. Herms has for many years laid emphasis on the ecological phases of the problem, which emphasis is the basis of all naturalistic control.

While naturalistic abatement has been directed mainly at the vectors of malaria, its principles are also applicable to pest mosquitoes, and in some instances, particularly here in California, notable successes have been achieved along this line.

Probably the best way to explain the use of naturalistic abatement measures will be to list some of the more important types, and then illustrate them from successful work throughout the world.

For convenience, and to assist in the organization of thought on the subject, we will group naturalistic measures into three categories—chemical, physical and biological, as follows:

A. *Chemical*
   1. Changing the salt content of water
      (a) Salinification
      (b) Freshening
   2. Pollution

B. *Physical*
   1. Silting
   2. Muddying
   3. Intermittent drying
   4. Constant level flooding with circulation
   5. Fluctuating water levels
   6. Controlled reflooding and redraining
   7. Flushing or sluicing
   8. Changes in sunlight
      (a) Shading
      (b) Clearing

C. *Biological*
   1. Introduction of natural enemies (parasites and predators)
   2. Changing flora and fauna to competitive or unsuitable types
   3. Elimination or destruction of aquatic food supplies

In the first group, the marsh at Durazzo, Albania is a good example of abatement by salinification. This sea coast marsh, being brackish, was a prolific breeder of *Anopheles sacharovi (elutus),* probably the most effective vector of malaria in the Mediterranean basin. By enclosing the marsh with a dyke, and admitting sea water through a control structure at high tide at one end of the marsh, and permitting the outflow of excess water at the other end, Hackett was able to increase the salt content of the marsh water sufficiently to make it unsuitable to the breeding of *Anopheles sacharovi,* with a marked decrease in malaria prevalence.

The reverse of this method is to reduce the salt content of a marshy area to the point below the minimum at which brackish water mosquitoes can breed. This is well illustrated by the marshes near Viareggio in Italy, and is perhaps the first example of the application of a naturalistic method in the control of malaria. Both the Romans and their Italian successors had noticed that brackish coastal marshes in Italy were unhealthy (malarious), while fresh water marshes were generally healthy. Obviously, then, if sea water could be excluded from these marshes, malaria should be eliminated. Acting on this idea, the Italian engineer Zendrini in 1740 constructed hinged gates which permitted the outflow of flood water from the marsh, but in summer excluded sea

water during the high tides. This freshening of the marsh water so reduced the breeding of the brackish water malaria vectors, *Anopheles maculipennis labranchiae* and *Anopheles sacharovi,* that this region has been healthy to this day, and Zendrini's gates are still functioning successfully after some two hundred years.

Another illustration of the effect on a mosquito species of changing the salinity of water is the case of *Anopheles sundaicus.* In the mangrove swamp areas of Malaya, this species can be controlled by lowering the salt content of the water below the optimum salinity, but in Java an increase in salinity in the fish ponds, above the optimum point, was equally effective in controlling this mosquito.

Some mosquitoes are rather fastidious in their preferences of breeding water, and will not reproduce appreciably in water which is polluted with organic refuse such as sewage or decaying vegetable or animal matter; some will not develop successfully in muddy water. Advantage may be taken of this characteristic of some species of mosquitoes. For example, in the vicinity of Canton, China, it has been found that green manuring and muddying the water in the rice paddies reduces the production of the malaria vector, *Anopheles hyrcanus sinensis.* Our California vector, *Anopheles maculipennis freeborni,* is also quite fastidious, and I have never found it breeding appreciably in highly polluted water, even when that was the only breeding water available. So far we have not been able to make use of this idea, as this species reproduces principally in shallow seepage from irrigation, and Mr. Gillespie, as well as our farmers, would undoubtedly object to the pollution of irrigation water for this purpose. Therefore we use other methods which are effective and less objectionable.

Dr. L. L. Williams, Jr., tells the story of a southern town which had a sewer system discharging into a marsh. In a campaign to improve the health and sanitation of the town, a sewage treatment plant was installed, and the marsh was no longer polluted. As a result, the pest mosquitoes formerly breeding in the marsh were in time supplanted by *Anopheles* vectors which thrived in the clean water of the unpolluted marsh, and malaria then increased as a result of a sanitary improvement, due to insufficient understanding of the ecology of mosquito species.

Filling in marsh areas by the natural silting of streams, guiding and controlling their flood flows, is another naturalistic control measure. More than five hundred acres of salt marsh in Alameda County have been eliminated as mosquito breeders by this method in the last ten years, and the process is continuing. In Ceylon, H. N. Worth is eliminating stream bed pools by a process of silting the sides of the stream bed and confining the flow to a central channel, using lines of closely set bamboo poles to form the silting basins.

(Continued in next issue)

PSITTACOSIS CONTROL

In southern California during the month of December 6339 shell parakeets and 882 larger psittacine birds were shipped out of the state under authorizations from this department. Eighty-one aviaries were inspected and 110 shell parakeets were destroyed in an aviary proven infected with psittacosis. Psittacosis infection was reported by the Wisconsin and the Connecticut State Health Departments in two persons and the infection traced to shell parakeets purchased in California. Birds from certain aviaries were placed under quarantine. Beginning January first no shell parakeets can be shipped out of California and plans are under way to test all psittacine aviaries in the state to determine where the infected birds are.

A regional meeting on Social Hygiene and the National Defense will be held in Los Angeles February 5 by the American Social Hygiene Association. Representatives of eleven Western States will be asked to attend. Among those who have consented to participate are: Dr. O. C. Wenger, United States Public Health Service; Dr. Walter Clarke, Executive Director, American Social Hygiene Association; Dr. Bertram P. Brown, Director California State Department of Public Health; Lt. Col. Harold Raycroft, United States Army; and Capt. Joel T. Boone, United States Navy.

Morning and afternoon sessions will be held in Porter Hall, University of Southern California, with a luncheon meeting in the Town and Gown club of the university. Discussion will center on the subject: How Government Agencies and Voluntary Groups Can Work Together to Protect United States Soldiers, Sailors and Workers in Defense Industries from Syphilis and Gonorrhea.

Another meeting on Fifth National Social Hygiene Day is scheduled in San Francisco under the auspices of the Health Council of the Community Chest. At a luncheon meeting in the Palace Hotel speakers will include: Dr. J. C. Geiger, Director, San Francisco Department of Public Health; Lt. Col. J. F. Corby, United States Army; and Capt. Edward U. Reed, United States Navy.

MORBIDITY

Complete Reports for Following Diseases For Week Ending January 11, 1941

Chickenpox

1032 cases: Alameda 2, Berkeley 9, Oakland 66, Piedmont 11, San Leandro 2, Chico 1, Contra Costa County 5, Walnut Creek 6, Crescent City 1, Fresno County 11, Fresno 8, Kingsburg 1, Humboldt County 2, Eureka 27, Imperial County 2, Kern County 26, Bakersfield 4, Corcoran 1, Hanford 1, Los Angeles County 58, Alhambra 4, Compton 2, Covina 3, Culver City 1, El Segundo 4, Glendale 5, Huntington Park 1, Inglewood 2, Long Beach 23, Los Angeles 48, Montebello 2, Pasadena 10, San Fernando 2, San Marino 2, Santa Monica 3, South Pasadena 1, Whittier 5, Hawthorne 1, South Gate 13, Bell 1, Madera County 9, Merced County 1, Gustine 1, Monterey County 13, Orange County 4, Anaheim 15, Fullerton 14, Orange 13, Santa Ana 11, La Habra 8, Riverside County 12, Blythe 1, Corona 1, Hemet 1, Riverside 9, Palm Springs 5, Sacramento County 24, Sacramento 80, San Bernardino County 8, San Bernardino 1, San Diego County 14, Coronado 1, National City 5, San Diego 50, San Francisco 92, San Joaquin County 55, Lodi 6, Stockton 6, Tracy 19, Paso Robles 7, Burlingame 1, Daly City 13, Redwood City 5, San Mateo 5, Belmont 4, Santa Barbara County 18, Lompoc 2, Santa Barbara 1, Santa Maria 12, Santa Clara County 5, Palo Alto 19, San Jose 22, Watsonville 1, Shasta County 1, Stanislaus County 20, Patterson 6, Sutter County 5, Tulare County 6, Porterville 1, Visalia 1, Oxnard 1, Yolo County 3, Davis 2, Woodland 13, Marysville 2.

Diphtheria

11 cases: San Leandro 1, Sanger 1, Los Angeles 3, Riverside County 1, San Francisco 1, Stockton 1, Sutter County 2, Tulare County 1.

German Measles

46 cases: Alameda County 1, Alameda 3, Livermore 10, Oakland 1, Fresno County 1, Claremont 1, Long Beach 6, Monterey County 1, Plumas County 7, Sacramento 1, San Diego County 3, Coronado 1, San Diego 1, San Jose 1, Shasta County 5, Solano County 1.

Influenza

2834 cases: Alameda County 249, Alameda 13, Berkeley 284, Livermore 3, Oakland 33, San Leandro 7, Chico 10, Contra Costa County 7, Fresno County 1, Fresno 15, Humboldt County 6, Fortuna 161, Calipatria 1, Inyo County 15, Kern County 47, Bakersfield 10, Delano 3, Tehachapi 87, Los Angeles County 416, Alhambra 490, Burbank 13, Claremont 2, Compton 5, Culver City 1, El Monte 59, El Segundo 10, Huntington Park 3, Long Beach 5, Los Angeles 388, Monrovia 1, Montebello 5, Pasadena 16, Pomona 2, San Gabriel 74, San Marino 1, Santa Monica 4, Whittier 1, Torrance 1, South Gate 2, Monterey Park 1, Maywood 2, Bell 3, Madera County 1, Yosemite National Park 2, Merced County 7, Mono County 4, Monterey County 5, King City 1, Monterey 1, Orange County 3, Anaheim 3, Fullerton 3, Santa Ana 3, Laguna Beach 4, Colfax 1, Riverside County 16, Corona 12, Riverside 1, Indio 15, Palm Springs 3, Sacramento 15, San Bernardino County 27, San Bernardino 1, San Diego County 1, San Francisco 103, San Joaquin County 16, Stockton 6, San Luis Obispo 10, San Mateo County 13, Burlingame 1, San Bruno 27, Santa Clara County 6, Palo Alto 16, San Jose 7, Stanislaus County 2, Corning 10, Ventura County 10, Ventura 1.

Measles

65 cases: Oakland 5, Colusa County 1, Kern County 2, Hanford 1, Los Angeles County 2, Burbank 1, Los Angeles 5, Pasadena 2, San Fernando 1, Santa Monica 1, Napa 1, Fullerton 1, La Habra 1, Sacramento County 2, Sacramento 1, San Diego County 2, Coronado 1, San Diego 5, San Francisco 1, Santa Barbara County 13, Lompoc 3, Santa Barbara 1, Santa Maria 1, Santa Clara County 3, Santa Cruz 1, Solano County 1, Vacaville 1, Corning 2.

Mumps

266 cases: Berkeley 1, Oakland 9, Pittsburg 1, Inyo County 3, Kern County 36, Delano 3, Los Angeles County 21, Glendale 6, Long Beach 39, Los Angeles 32, Pasadena 1, Pomona 3, Whittier 1, South Gate 1, Marin County 1, Orange County 16, Fullerton 4, Huntington Beach 8, Orange 1, Santa Ana 7, Seal Beach 1, La Habra 3, Laguna Beach 1, Placentia 1, Riverside County 2, Blythe 1, San Jacinto 1, Indio 12, Sacramento County 1, Sacramento 1, San Bernardino County 1, San Diego County 1, El Cajon 3, San Diego 14, San Francisco 10, Paso Robles 1, San Mateo County 1, Palo Alto 1, Santa Cruz County 5, Solano County 4, Tulare County 3, Exeter 2, Fillmore 1, Yolo County 1.

Pneumonia (Lobar)

106 cases: Alameda 1, Berkeley 1, Oakland 5, Pittsburg 2, Fresno County 1, Coalinga 1, Kern County 1, Los Angeles County 16, Huntington Park 1, Long Beach 2, Los Angeles 39, Pasadena 1, Redondo 1, San Fernando 2, San Gabriel 1, Monterey County 1, Orange County 1, Anaheim 1, La Habra 1, Sacramento County 1, Sacramento 2, North Sacramento 1, San Bernardino County 1, San Francisco 6, San Joaquin County 7, Manteca 1, Stockton 6, Santa Clara County 1, San Jose 1.

Scarlet Fever

131 cases: Alameda County 1, Oakland 6, Crescent City 2, Placerville 1, Fresno County 8, Fresno 2, Kern County 7, Corcoran 1, Los Angeles County 13, Burbank 1, El Segundo 1, Huntington Park 1, Long Beach 2, Los Angeles 22, Pasadena 3, Pomona 2, San Fernando 1, San Gabriel 1, Whittier 1, Lynwood 2, South Gate 14, Gardena 1, Orange County 2, Fullerton 1, Lincoln 1, Plumas County 2, Sacramento 2, San Bernardino 2, San Diego County 1, National City 1, San Diego 4, San Francisco 7, San Joaquin County 2, Manteca 1, Stockton 3, San Luis Obispo 1, Santa Cruz County 2, Solano County 1, Tulare County 1, Lindsay 1, Ventura County 3.

Smallpox

No cases reported.

Typhoid Fever

6 cases: Fresno County 3, Fresno 1, Los Angeles County 1, San Bernardino 1.

Whooping Cough

421 cases: Alameda County 1, Alameda 4, Berkeley 19, Oakland 25, Piedmont 2, San Leandro 1, Chico 1, Contra Costa County 1, Concord 14, Placerville 2, Fresno County 3, Kern County 3, Los Angeles County 60, Alhambra 3, Burbank 1, El Segundo 2, Glendora 1, Long Beach 18, Los Angeles 52, Montebello 1, Pasadena 1, Redondo 4, Santa Monica 4, South Gate 8, Maywood 1, Bell 1, Monterey County 2, Salinas 1, Orange County 19, Anaheim 1, Huntington Beach 1, Newport Beach 5, Orange 5, Santa Ana 12, Seal Beach 1, Laguna Beach 5, Tustin 2, Riverside County 1, Corona 3, Riverside 1, Sacramento 4, San Bernardino County 5, San Diego County 9, Chula Vista 1, Escondido 1, San Diego 16, San Francisco 42, San Joaquin County 18, Stockton 1, San Luis Obispo County 8, San Luis Obispo 3, Santa Barbara County 2, Santa Barbara 7, Santa Clara County 1, San Jose 3, Shasta County 2, Modesto 2, Ventura County 1, Fillmore 2, Ventura 1.

Meningitis (Epidemic)

One case: Dinuba.

Dysentery (Bacillary)

4 cases: Los Angeles County 1, Los Angeles 3.

Poliomyelitis

One case: Riverside.

Tetanus

One case: San Joaquin County.

Trachoma

One case: Santa Clara County.

Encephalitis (Epidemic)

One case: San Joaquin County.

Paratyphoid Fever

One case: San Francisco.

Trichinosis

2 cases: Fort Bragg.

Typhus Fever

One case: Los Angeles.

Food Poisoning

5 cases: San Francisco.

Undulant Fever

One case: Monterey County.

Epilepsy

22 cases: Oakland 1, Los Angeles County 2, Glendale 1, Los Angeles 12, Pasadena 2, Marin County 1, Napa County 1, San Mateo County 2.

Rabies (Animal)

21 cases: Los Angeles County 3, Los Angeles 7, Riverside County 2, Riverside 4, Daly City 3, Tulare County 1, Porterville 1.

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Guy P. Jones
Editor

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California State Department of Public Health

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